JAXA Software IV&V activity 2005

Pre-SAS @ NASA IV&V Facility
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Outline of JAXA IV&V tasks

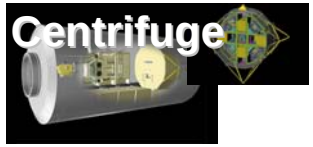
- Purpose
  - Projects' IV&V software assessment
  - Research of new software engineering methodologies
  - Introducing those methodologies into development team and contractors

1. **New Methodology Research**
   - Research and Development of new methodology based on projects' needs (focused points for particular projects' weakness) and case studies
   - International collaboration with other IV&V facilities such as NASA, ESA
2. **Methodology empirical verification**
   - Sample application in real projects to verify the effectiveness of methodologies
   - Building up lessons learned and effectiveness data for projects' characteristics
3. **Projects' IV&V**
   - Based on Project team requests, planning the IV&V by selecting methodologies from verified storage
   - IV&V assessment reports at milestone reviews

Project IV&V Status(2004.4-2005.7)

Manned Systems

・Navigation & Guidance



・Rotor

・JCP
・RMS

Full set

Lightweight

Satellites

・Data Handling
・Attitude Control

・Data Handling
・Attitude Control
・Antenna Drive

From early phase of development

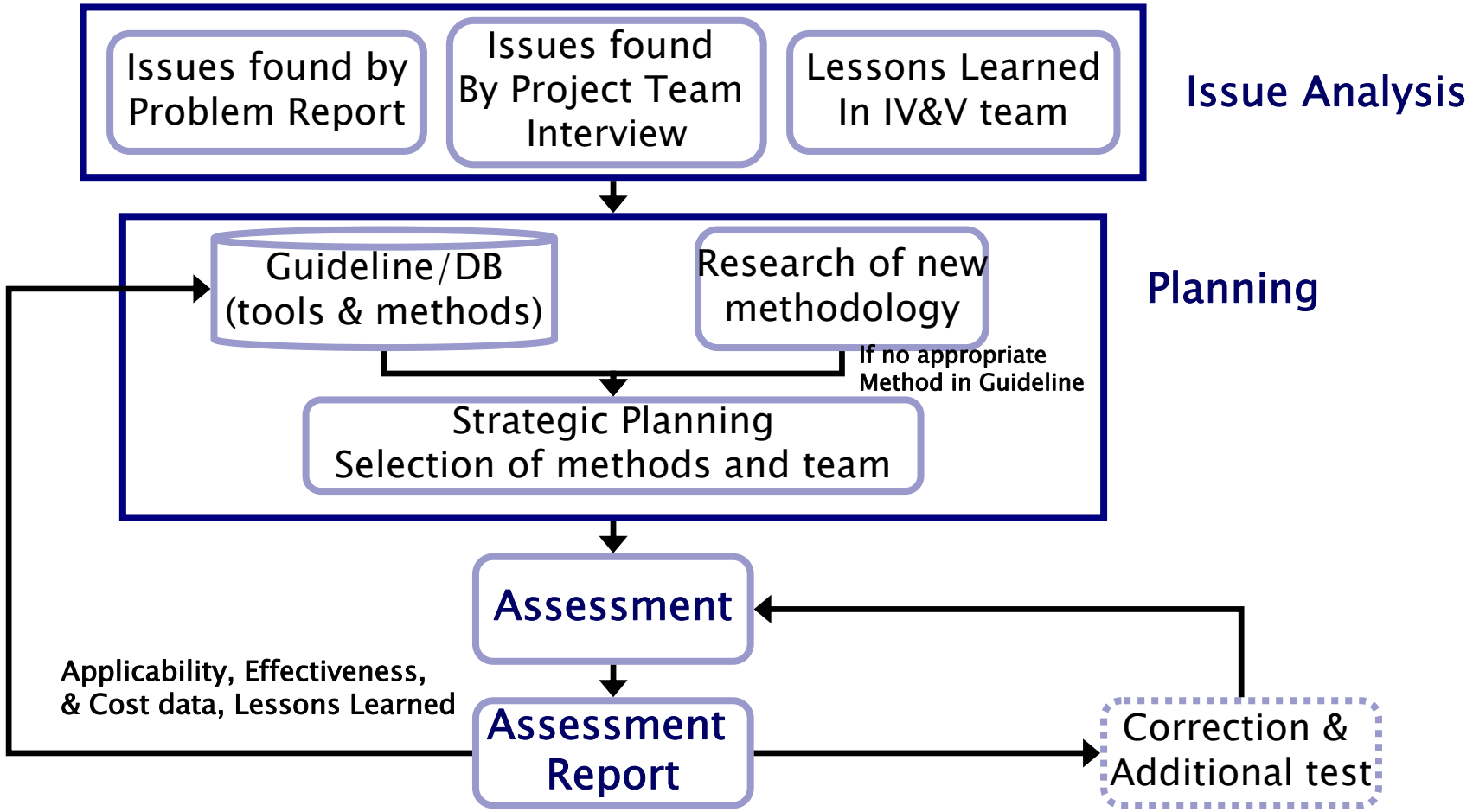
・ Mission Data Handling

Ground Segments

JEM operation control system

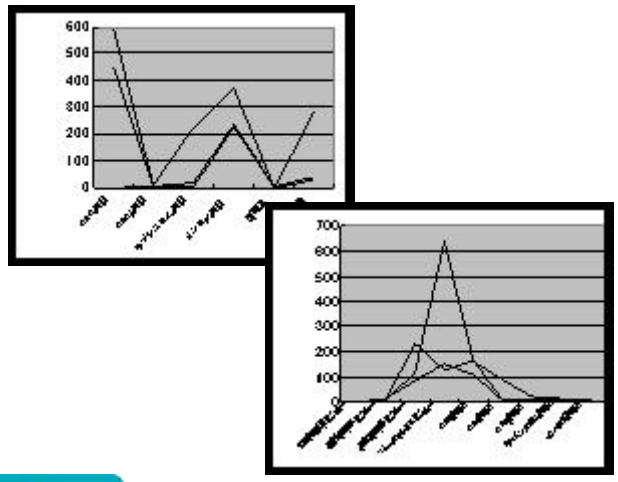
H-IIA Launch Vehicle flight safety system

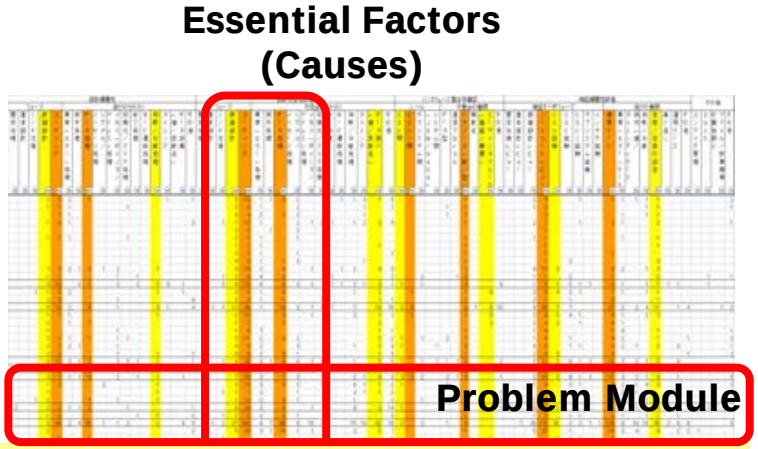
IV&V flow


Issues found by Problem Report
Issues found By Project Team Interview
Lessons Learned In IV&V team
Issue Analysis
Guideline/DB (tools & methods)
Research of new methodology
If no appropriate Method in Guideline
Planning
Strategic Planning Selection of methods and team
Assessment
Applicability, Effectiveness, & Cost data, Lessons Learned
Assessment Report
Correction & Additional test

Issues found by Problem Report

- Problem Trend Assessment
  - Type of problem
  - Process (Task) in which a problem was introduced
  - Process (Task) in which a problem has been found
  - Process (Task) in which a problem should have been found
  - Related or similar software modules
- Statistical Analysis (Software Reliability Growth Model: SRGM)
  - Adjustment by size of efforts and stepwise testing
- Comparison with measurement data such as the complexity calculated by code checking tool
  - Problem Reports vs. corrective actions





- What can be studied are:
  - Trend of root causes for each software/each team & staff
  - Satisfaction of software test and reviews/inspection
  - Findings of weak processes and problem module which IV&V should focus on
  - Integrity level of product and processes (Fault Tolerance and Robustness)

▸▸ Feedback to development process (additional reviews and testing

New Methodologies Research 2004-2005

- SpecTRM Based Robustness Test Environment (SpecRobusT) which is an automated test case generation, testing, test results comparison environment ⇒ Manned Systems
- IV&V Review of Requirements Management and Traceability Analysis

- Checklist for Satellite Data Handing system ⇒ Satellites
- Tool supported interface verification ⇒ Ground Segments
- Meta Modeling Language and Model Checking with IV&V and Development Team
- Code Clone Technology to use reliability measurement
- Maps for software test technology for ultra high reliable software which is cooperate with other area of industries

SpecTRM (Model) Based Robustness Test Environment (SpecRobusT)

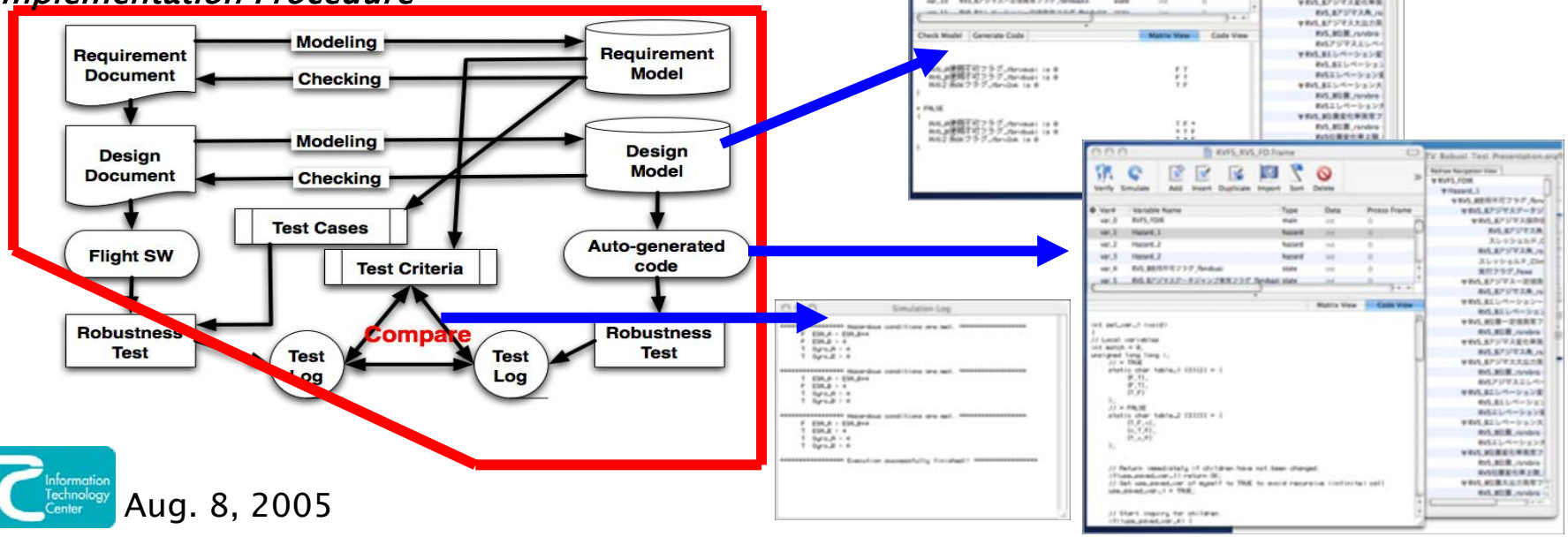
Outline:

- By using specification models, the important test cases are generated for full software simulation during development contractor's test phase automatically and comparing results.
- Especially, all inputs are verified in the model to generate the test cases.
- Auto tests are performed at 10,000 – 100,000 cases / sec.

Results:

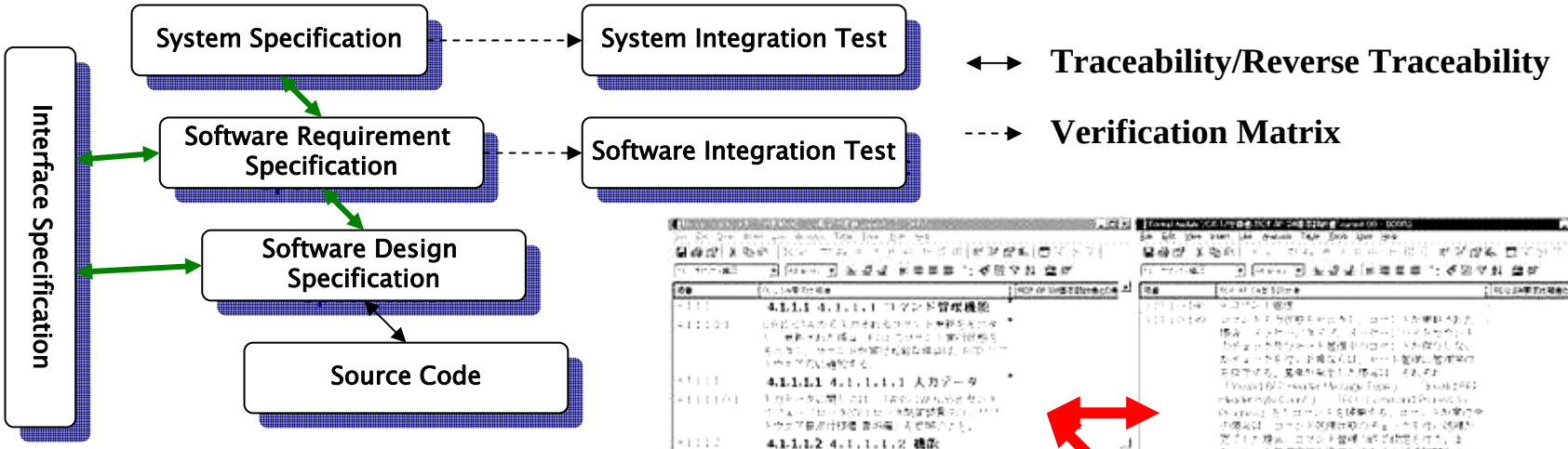
- # of Test Case : 550,870,000,000
- Benefits:
  - Verification at very early phase
  - Introduction to automated test environment
  - Introduce "Test Before Development" paradigm into development process

Implementation Procedure



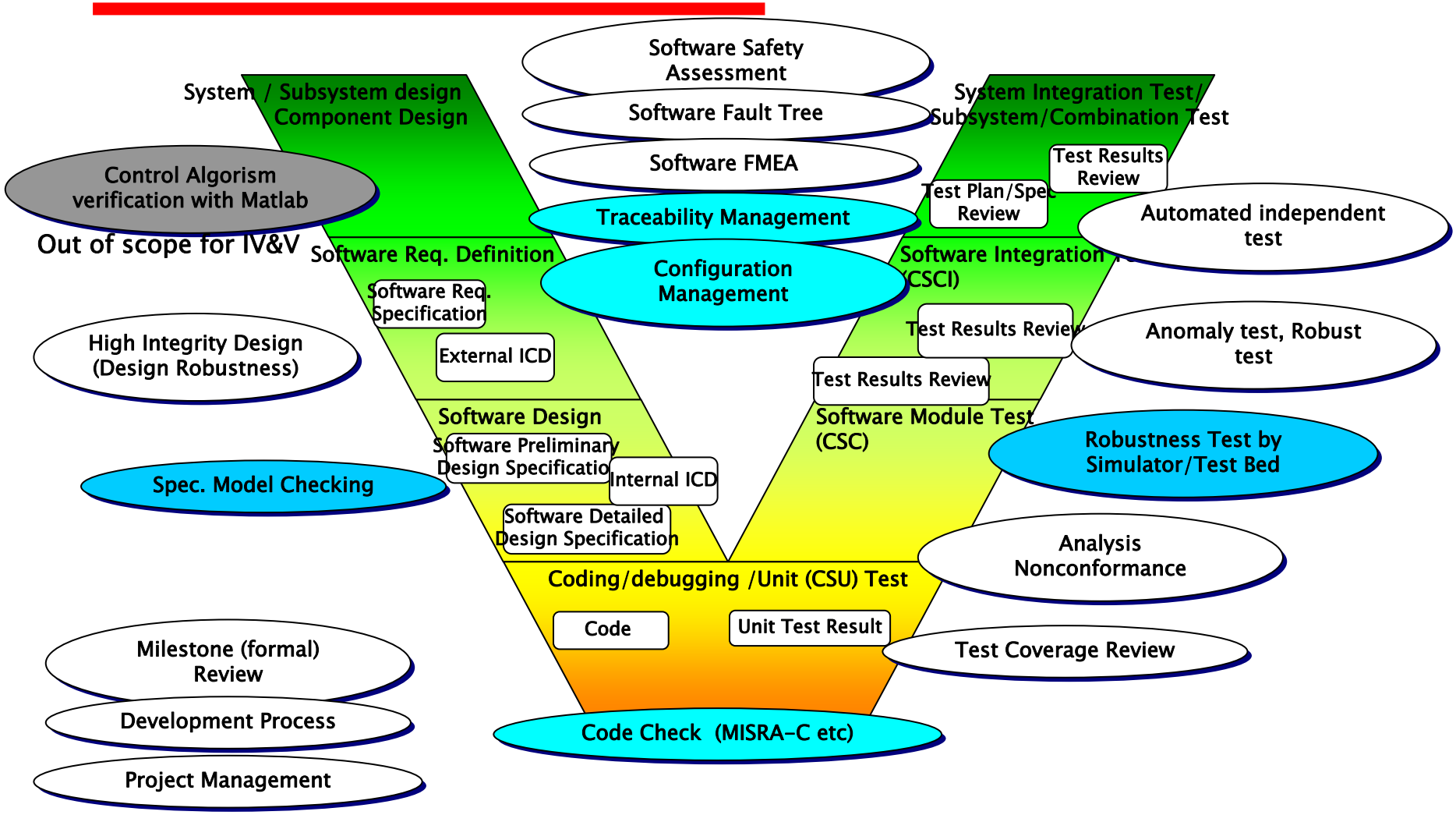
IV&V Review of Requirements Management and Traceability Analysis

- DOORS/Add-on Toolset

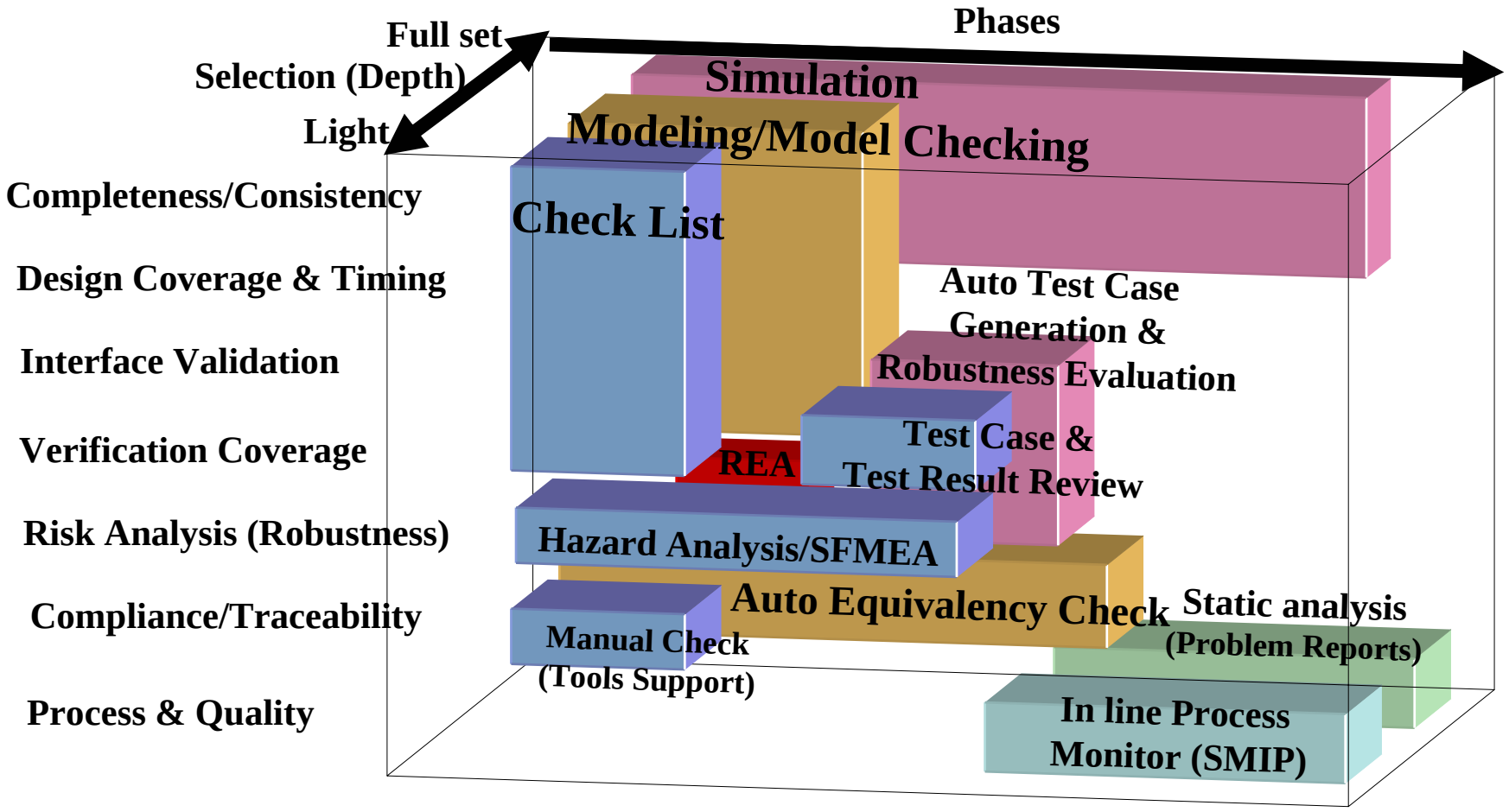


- Lessons Learned
  - Independent Review of traceability correctness and specification completeness
  - Particular granularity of specification description
  - Tracking rationales of specification (Add-on Toolset)
  - Difficulty of treating tables and figure definition instead of sentence

IV&V Activities Map along software lifecycle

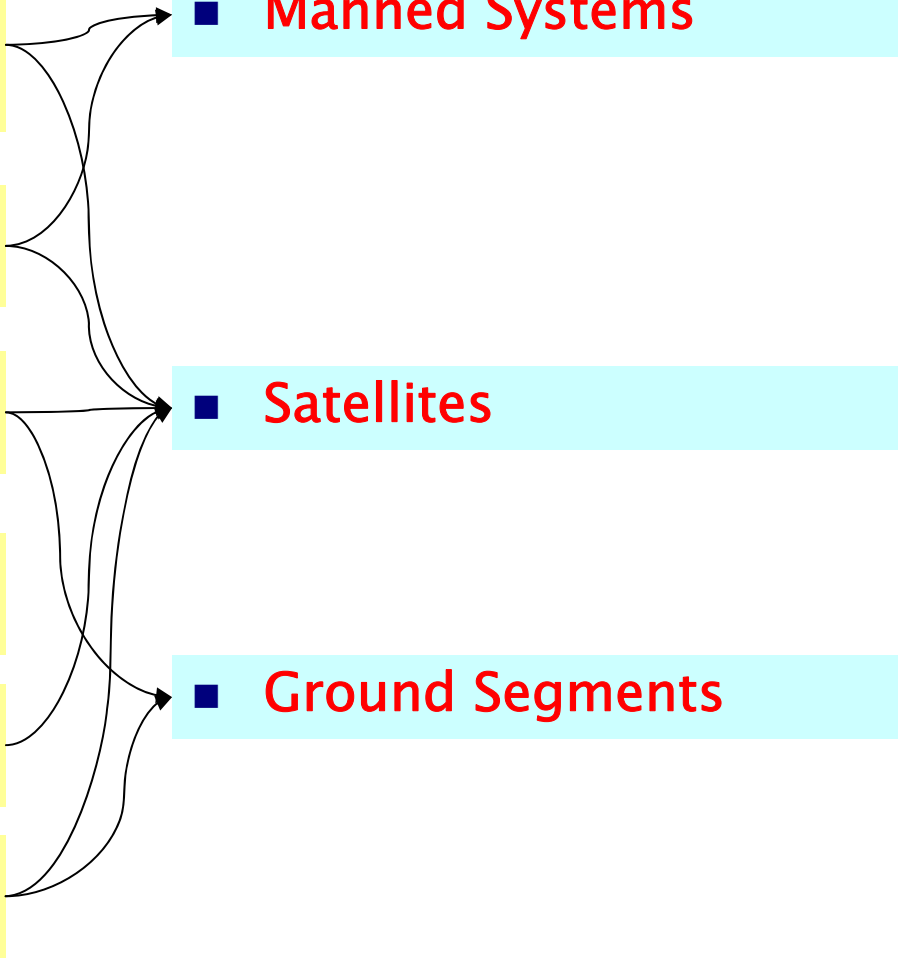


Selection and Scalability of Methodologies



Examples of methodologies selection

- Completeness, Consistency, and Reachability (model checking) by using formal specification
- Test case generation and reasonable case deduction at IV&V review
- Analysis of Design Robustness and Coverage
- Problem Report Analysis and Accident Analysis
- Verification by reverse engineering tools
- Code Static Analysis by code checking tools



Strategic IV&V planning

- Restructuring IV&V methodologies by the following categories:
  - Purpose (5 majors, 17 minors)
    Consistency with Operational scenario, Adequacy of specification, ...etc.
  - Attributes (79 attributes)
    Consistency of State Transition, Timing Consistency, ...etc.
  - Techniques (109 techniques)
    SpecTRM modeling, Voyager-Galileo Checklist, ...etc.
  - Several data for all above combination, such as cost-effectiveness and effectiveness to severity of system are defined for modeling IV&V tasks toward future strategic IV&V planning
- We have just started to take those data and analyze them.
  All results will be presented in IV&V TIM@ ESTEC in October, 2005.

Additional Topic in Software Engineering Team:

Software Process Improvement

- Purpose
  - To define the integrated process between JAXA and Contractors including IV&V
  - To monitor the goodness of process in order to avoid being dead process by using metrics etc.
  - No target to particular level such CMMI level 5

- First Goal
  - Gap analysis and finding process issues
    - Interviews : JAXA, Contractor Engineers and Managers
    - Problem Reports Analysis (more than 2000)
    - Giving self-improvement motivation into contractors
  - Integrated Process and Process Standard (at first, satellite version will issue in 2005)
    - establishes a stable development process
    - makes clear on the Roles and Responsibilities of both JAXA and contractors, and their process interfaces
  - Introduction of new tools and methods such as process and product metrics

Additional Topic in Software Engineering Team:

High Reliable Real-Time (RT) OS/ Verification Process

- Purpose
  - To Establish the high reliable verification process in order to assure enough quality and reliability of RTOS.

- Topics
  - Establishment of High Reliable Verification Process (as Standard)
    - Minimum Verification Process Requirement to assure RTOS (additional testing)
  - High Reliability functions implementation
    - (Open Source) RTOS which can provide the function to be supportive to develop enough safety system

Current works and Future works

- Model Based Assessment
  - Model Checking to Model Based Development
  - Analysis of consistency between operation tasks and system specification behaviors
- Test Bed
  - Independent Test based on CPU emulators for code robustness check
  - Software Test Bed for New 200MIPS MPU
- Operational Scenario Assessment
  - Study the modeling method to analyze the operational scenario from early phase of development